HURRICANE SURVEY

INTERIM REPORT

NEW HAMPSHIRE COASTAL AND TIDAL AREAS

U.S. Army Engineer Division, New England
Corps of Engineers
Waltham, Mass.

ENGINEERING DIVISION WORKING COPY
RETURN TO FILE

28 May 1964

SYLLABUS

The major cause of storm damage along the New Hampshire coast, from tidal flooding and wave attack, is the "northeaster" coastal storm, not hurricanes. The record level of flooding, experienced in the "northeasters" of 30 November 1944 and 29 December 1959, is 8.4 feet, mean sea level, with flooding to nearly the same level, 8.3 feet, mean sea level, being experienced in the recent storm of 20 January 1961. These record levels are 1.5 to 1.6 feet above the stage of an annual high spring tide. The highest recorded stage of flooding in a hurricane is 7.7 feet, mean sea level, which was experienced in Hurricane "Carol" on 31 August 1954. Flooding along the New Hampshire coast in the hurricanes of September 1938 and September 1944, which were severe in southern New England, did not reach the stage of a high spring tide.

The damages from tidal flooding in the past have been small. In the December 1959 storm, which caused the record flood level, the damages to shore properties amounted to an estimated $60,000. The damages, other than damages to boats, in the January 1961 storm with a near record flood stage, were reported as being minor in amount and resulting mainly from the flooding of low-lying highways. In view of the small amount of damage, it has

been determined that it is impractical to provide protection against tidal flooding along the coast. The present problem is principally one of preventing the gradual deterioration of the state's beaches by erosion. Previously constructed and recommended beach erosion control measures, in addition to preserving much of the present shorefront, will also serve to effect some reduction in the flood and wave damage caused by "northeasters" and hurricanes.

It is concluded that it would be desirable for local interests to give serious consideration to the following measures to lessen future tidal-flood losses:

1. The establishment and/or modification and expansion of present emergency mobilization measures for the evacuation of the flood plain, where required, taking into account such factors as the need for improvement of escape or evacuation routes, periodic notification of residents in flood-prone areas of the flood danger, and availability of plans and programs for emergency warning and evacuation.

2. The adoption of zoning regulations to control future development within the area of tidal flooding.

3. The adoption of building regulations establishing minimum elevations for first floors in new construction, and

requiring improved construction methods in areas subject to flooding.

4. The completion of measures that have been previously recommended to control the erosion of the beaches and preserve the shore line. The protection and improvement of the natural beaches of New Hampshire is desirable since they form a first line of defense against storms and are an important recreational asset.

The Division Engineer recommends that no improvements for hurricane protection in the coastal and tidal areas of New Hampshire be undertaken by the United States at this time.

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U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
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ADDRESS REPLY TO:
DIVISION ENGINEER

REFER TO FILE NO.

NEDED-R

28 May 1964

SUBJECT: Hurricane Survey Report on New Hampshire Coastal and Tidal Areas

TO: Chief of Engineers
ATTN: ENGCW-PD
Washington, D. C.

AUTHORITY AND INTRODUCTION

1. In view of severe hurricane damages experienced in the eastern and southern coastal areas of the United States, the 84th Congress on 15 June 1955 adopted Public Law No. 71 which authorized the Corps of Engineers to undertake a study of means to prevent the loss of human lives and damage to property from hurricane tidal flooding in these areas.

The authorizing legislation provides that first consideration be given to areas where severe damages have occurred. Studies have therefore been completed on critical areas along the Massachusetts, Rhode Island and Connecticut coasts in southern New England. These studies have led to the authorization for construction of 10 projects, three of which have either been completed or are currently underway. In addition, these past studies have led to recommended proposals for hurricane tidal protection projects at two other locations. This report, covering the coastal and tidal areas of New Hampshire, is one of a series for the remaining shore areas for which previous hurricane survey reports have not been prepared. The results of these studies are intended to serve as a guide for future planning and to encourage the adoption of measures which will further the work initiated by the Federally constructed and authorized projects.

DESCRIPTION

2. The coastline of New Hampshire extends northerly along the Atlantic Ocean from the Massachusetts State line to the Piscataqua River and the entrance to Portsmouth Harbor at the Maine State line. It includes the shores of the Towns of Seabrook, Hampton, North Hampton, Rye, and New Castle with a total length of about 18 miles. Approximately eight miles, or over 42 percent of the total shoreline, consist of sandy barrier beaches that are extensively utilized for public and private recreation. They are located principally along the southern half of the state's seashore. To the north, the shore line becomes increasingly irregular with the appearance of a number of bedrock exposures.

ECONOMIC DEVELOPMENT

3. GENERAL.

The accommodation of summer residents and visitors is the principal source of income in the five towns along the Atlantic coast of New Hampshire. Manufacturing, commercial shipping, and recreational boating are also important factors in the region's economy. The area is served by a network of highways and by the Boston and Maine Railroad with a main line two to four miles inland from the shore. Operation of the Portsmouth Naval Base in Kittery, Maine, on the north bank of the Piscataqua River, across from Portsmouth, plays a very important role in the region's economy.

4. POPULATION.

The year-round population of the five coastal towns was 13,565 in 1960, an increase of nearly 65 percent over 1950. Including the city of Portsmouth on the Piscataqua River, the 1960 population of the area was 40,283 which represents approximately 6.5 percent of the total population of the state. The population of the coastal towns increases markedly during the summer from an influx of vacationists. The summer population along the coast is estimated at over 60,000, principally in Hampton, which on weekends may have a population of 85,000 to 100,000.

5. INDUSTRY.

The principal industrial center in the area is Portsmouth. Among the more important industries in this city are the manufacture of shoes, gypsum products, and submarine cables. The generation of electrical power and the operation of bulk terminals for the distribution of coal and petroleum are also important activities at Portsmouth.

6. NAVIGATION AND COMMERCE.

There are four authorized Federal navigation projects in the study area along the New Hampshire coast, with project depths ranging from 6 to 12 feet at mean low water. Three are principally for the benefit of recreational craft and small fishing boats. These include projects at Little and Rye Harbors which have been substantially completed and one at Hampton River and Harbor which was recently authorized. A channel 35 feet deep is available in the Piscataqua River from the sea to near the Portsmouth-Newington town line. An extension of this channel upstream about two miles has been authorized and the initiation of its construction is planned during the 1964 construction season.

The total waterborne commerce in New Hampshire in 1962, including receipts and shipments, amounted to nearly 1,455,000 tons. All of this tonnage, with the exception of less than 100 tons of fish and shellfish at Rye Harbor, was handled at Portsmouth. About 1,195,000 tons, or 82 percent of the total 1962 commerce, consisted of the receipts of petroleum and petroleum products; over 145,000 tons, or about 10 percent of the total, the receipt of gypsum; and about 95,000 tons, the receipt of bituminous coal.

7. RECREATION.

The provision of services associated with outdoor recreational activity is of growing importance in the economic life of the New Hampshire seacoast region. Its favorable location with respect to the densely populated areas of southern New England causes an increasing demand on the recreational facilities of the area. The largest concentrations of coastal population and development are at Hampton and Seabrook. Nearly three miles of shore

are open to public use at Hampton and North Beaches in Hampton. North Hampton has a public bathing beach on State-owned property at the north end of North Hampton Beach. The State owns a park at Ragged Neck Point and a public bathing beach at the north end of Wallis Sands Beach, both in Rye. About 12 miles, or approximately 63 percent of the total shoreline, are owned by either the state or the town; and over two miles are in Federal ownership.

Portsmouth Harbor and connecting inland waterways are extensively used by recreational craft. Recreational boating along the shore south of Portsmouth Harbor, however, is limited largely to boats which can safely operate in the open ocean since there are only two harbors, Rye and Hampton, along this 18 miles of oceanfront which are available for refuge. These latter two harbors contain facilities for the accommodation of recreational craft and small fishing boats.

TIDAL FLOODING

8. Data on the experienced heights of past tides are available from the records of U. S. Coast and Geodetic Survey gages at Boston, Massachusetts, and Portland, Maine, for periods extending over the past 40 or more years, and at Portsmouth, New Hampshire, for the past 20 years. These, together with other storm records, reveal that the highest levels of tidal flooding along the New Hampshire coast have been caused by coastal storms, commonly referred to as "northeasters", and not by hurricanes. The history of coastal storms in New England, including hurricanes, goes back to the time of the first white settlers. Nearly all of the more severe "northeasters" have occurred during the winter or early spring months, from November through April, whereas the more damaging hurricanes have been experienced in the late summer, most frequently in August and September.

The mean range of tide along the New Hampshire coast is approximately 8.5 feet, from 4.1 feet below to 4.4 feet above mean sea level. A high spring tide will reach an elevation of approximately 6.8 feet msl, or 2.4 feet above mean high water.

The record level of tidal flooding is approximately 8.4 feet msl. This stage was reached in the "northeasters" of 30 November 1944 and 29 December 1959. Nearly the same level,

flooding to 8.3 feet msl, was experienced in the recent storm of 20 January 1961. The highest stage of tidal flooding occasioned by a hurricane was approximately 7.7 feet msl in Hurricane "Carol" on 31 August 1954. The flood levels in New Hampshire in the September 1938 and September 1944 hurricanes, which were particularly severe in southern New England, were 6.5 and 5.4 feet msl, respectively, or less than the stage in an annual high spring tide. The record tide level of 8.4 feet msl is about 1.5 feet above a high spring tide.

The observed tide heights at Boston, Massachusetts, and Portland, Maine, in five "northeasters" and three hurricanes, and estimated average levels of flooding along the New Hampshire shore, are tabulated below.

Table I

TIDAL FLOOD ELEVATIONS

BOSTON, MASS. TO PORTLAND, MAINE

Storm	Tidal Elevations (feet msl) Boston (Observed)	New Hampshire (Estimated)	Portland (Observed)
21 September 1938 (1)	6.4	6.5	6.8
14 September 1944 (1)	6.6	5.4	5.0
30 November 1944	6.8	8.4 (2)	8.7
20 November 1945	7.9	8.0	8.7
31 August 1954 (1)	8.2	7.7	7.9
29 December 1959	9.3	8.4 (2)	8.5
20 January 1961	9.3	8.3	8.3
30 November 1963	7.4	7.5	7.9

(1) Hurricane
(2) Record high

A survey of "northeasters" affecting the northern New England coast is contained in a report, Memorandum HUR 8-5, subject: "Criteria for a Standard Project Northeaster for New England North of Cape Cod", dated 28 May 1963, prepared by the Hydrometeorological Section, Hydrologic Services Division, U.S. Weather

Bureau. The survey includes a description of the characteristics and a short history of "northeasters", and a frequency analysis of the tides and storm surges in such storms.

TIDAL FLOOD DAMAGES

9. The damages from tidal flooding along the 18 miles of New Hampshire shorefront have been moderate in the past. In Hurricane "Carol" on 31 August 1954, with flooding to about 7.7 feet msl, the estimated damages, excluding wind damage, amounted to about $20,000. In the storm of 29 December 1959, which caused flooding to the record level of 8.4 feet msl, the damages to shore properties, excluding damage to boats, fish traps, and similar items, amounted to an estimated $60,000. In the two recent storms of 20 January 1961 and 30 November 1963, when flooding was experienced to levels of 8.3 and 7.5 feet msl, respectively, the reported damages, other than damages to boats blown ashore, were minor in amount and resulted mainly from the flooding of low-lying roads.

TIDAL-FLOOD PROTECTION MEASURES

10. A relatively small amount of damage has been sustained along the New Hampshire coast by reason of tidal flooding. The long lengths of available sandy beaches, particularly in the southern part of the state, are extensively used during the summer. These beaches are subject to accelerated erosion from coastal storms. As the population continues to expand and recreational pressure becomes even more intense, the provision of further protective measures to retain these valuable beach resources may be found desirable.

Protective measures for reducing tidal flood damages fall into the following general classes:

a. Positive protective structures. These measures include structures such as barriers, with gated or ungated openings, which would completely or partially close off a waterway to the entry of hurricane tides; dikes and seawalls which would hold back the high water; and breakwaters which would effect a reduction in the height of hurricane waves. Measures to protect and restore the shore, such as rock revetment and beach raising and widening, would offer partial flood protection to shorefront and inland properties. Such work can be combined with other water resource development measures as they become desirable and economical.

b. Flood proofing, strengthening, or relocating existing buildings. Following Hurricane "Carol" in 1954, a number of homes and other buildings in southern New England were relocated or raised to place their first floor level above the height of expected future hurricane tides. To mitigate future tidal flood losses along the New Hampshire shore, consideration should be given to the permanent relocation of goods and equipment to floor levels, above the highest experienced tidal flood level, relocation out of the flood plain, flood proofing, and/or more substantial construction to resist the destructive forces of high water and waves.

c. Restrictive zoning regulations and building codes. The adoption of flood plain zoning regulations and modified building codes requiring sturdier construction can be effective steps in controlling the future development of flood prone areas to make them less vulnerable to the hazards of hurricane tidal flooding.

d. Hurricane warning and emergency flood mobilization measures. These measures, coupled with plans for evacuation, including the improvement of escape routes, are feasible measures to lessen property damage in areas subject to large damage in future storms. All of the coastal towns should adopt programs for the evacuation of residents who live in flood prone areas and for their accommodation during the emergency period. These evacuation programs, together with the hurricane warning services now provided by the U. S. Weather Bureau, are essential supplements to other protection plans for the area. An example of mobilization measures that can be taken is contained in a report entitled "A Model Hurricane Plan for a Coast Community." This report was prepared in 1959 by the Weather Bureau, U. S. Department of Commerce, in collaboration with the Corps of Engineers.

SHORE EROSION

11. The present problem along the New Hampshire coast consists principally of the loss or deterioration of the recreational beaches through gradual erosion and storm wave attacks. Erosion has resulted in the loss of protective beaches that front developed shore areas thereby exposing these areas to potential damage at times of severe storms. The problem is not one of recent origin, but has become more intense owing to the increased use of the shorefront for recreation.

Improvements by the State were initiated in 1933 with (a) the construction of dikes and jetties to stabilize Hampton Harbor inlet, (b) the reclamation of 50 acres of land at Hampton Beach, adjacent to the north jetty, by the placement of sand dredged from the harbor, and (c) the construction of a concrete seawall at North Beach, all in Hampton. During 1946-1947 a new seawall was constructed by the State at the Hampton Beach business center, and revetment was placed along a portion of the shore at the south end of the center. Private improvements in the interest of stabilizing the shore consisted of a wide variety of structures, primarily seawalls, bulkheads, and riprap revetment at a number of locations particularly in Rye, Hampton and Seabrook.

The River and Harbor Act of 3 September 1954, authorized Federal participation to the extent of one-third the first cost of restoring, protecting and improving 5,200 feet of Hampton Beach, north of Haverhill Street, by the direct placement of sand fill, as recommended in House Document No. 325, 83rd Congress, 2nd Session. This project was completed by the State in 1955.

A cooperative beach erosion control study of the entire New Hampshire coast was completed and submitted to Congress in 1962 and is contained in House Document No. 416, 87th Congress, 2nd Session. This resulted in the authorization in 1962 of projects providing for Federal participation to the extent of one-third the cost of (a) improving 1600 feet of beach at North Hampton Beach and 800 feet at Wallis Sands Beach by the direct placement of sand fill and the construction of one impermeable groin at each beach, and (b) constructing an impermeable groin at Hampton Beach and providing periodic nourishment of the beach for an initial period of 10 years from the year of the first nourishment operation.

The 1962 report also presents protection plans which merit consideration for 15 locations along the entire shore, from Seabrook to New Castle. It recommends that any protective measures which may be undertaken by local interests be accomplished in accordance with the methods described in the report. These improvements consist of one or more of the following at each problem locality: (a) widening of beaches by direct placement of sand fill, (b) constructing groins, (c) placement of riprap revetment at toes of headlands and existing walls and bulkheads,

(d) constructing stone mounds and mortared stone walls, and (e) constructing steel sheet pile bulkheads. The design tide used in the report is 12.0 feet above mean low water (nearly 8.0 feet msl) which is only about one-half foot below the record level of tidal flooding experienced in November 1944 and December 1959.

DISCUSSION AND CONCLUSIONS

12. Northeast storms, rather than hurricanes, constitute the major cause of tidal flooding and wave damage along the New Hampshire coast. The record level of tidal flooding experienced in the storms of November 1944 and December 1959 is about 1.5 feet above the level of a high spring tide. Flooding to the record level would cause damages estimated at less than $100,000 to shore properties. This damage would be scattered along the 18 miles of the state's shore line with approximately one-third being located in Rye and one-third in Hampton.

The growing demand for shorefront properties in recent years has resulted in increased property values along the coast, and emphasized the need to prevent damage to these areas through erosion. The natural beaches form an essential line of defense against the attacks of "northeasters" and other storms. The restoration, protection, and improvement of shore areas is therefore a desirable first step towards the prevention of damages to shore properties in future storms. Completion by local interests of the several improvements previously recommended in the interest of beach erosion control, as outlined in House Document No. 416, 87th Congress, 2nd Session, would assist in preserving the shorefront and at the same time serve to effect a reduction in the flood and wave damages that would be experienced in future storms.

Owing to the relatively small amount and scattered nature of damage that would be sustained along the shore in a recurrence of the record flood level, it has been concluded that under present economic conditions and current requirements for Federal participation, the provision of positive tidal flood protection measures to and above the record level, are not warranted at this time. It has also been concluded that it would be desirable for local interests, both public and private, to give serious consideration to the following measures to lessen future damages from tidal flooding:

a. The establishment and/or modification and expansion of present emergency mobilization measures for the evacuation of the flood plain where required, taking into account such factors as the need for improvement of escape or evacuation routes, periodic notification of residents in flood-prone areas of the flood danger, and availability of plans and programs for emergency warning and evacuation.

b. The adoption of zoning regulations to control future development within the area of tidal flooding.

c. The adoption of building regulations establishing minimum elevations for first floors in new construction, and requiring improved construction methods in areas subject to flooding.

d. The completion of measures that have been previously recommended to control the erosion of the beaches and preserve the shore line. The protection and improvement of the natural beaches of New Hampshire is desirable since they form a first line of defense against storms and are an important recreational asset.

RECOMMENDATIONS

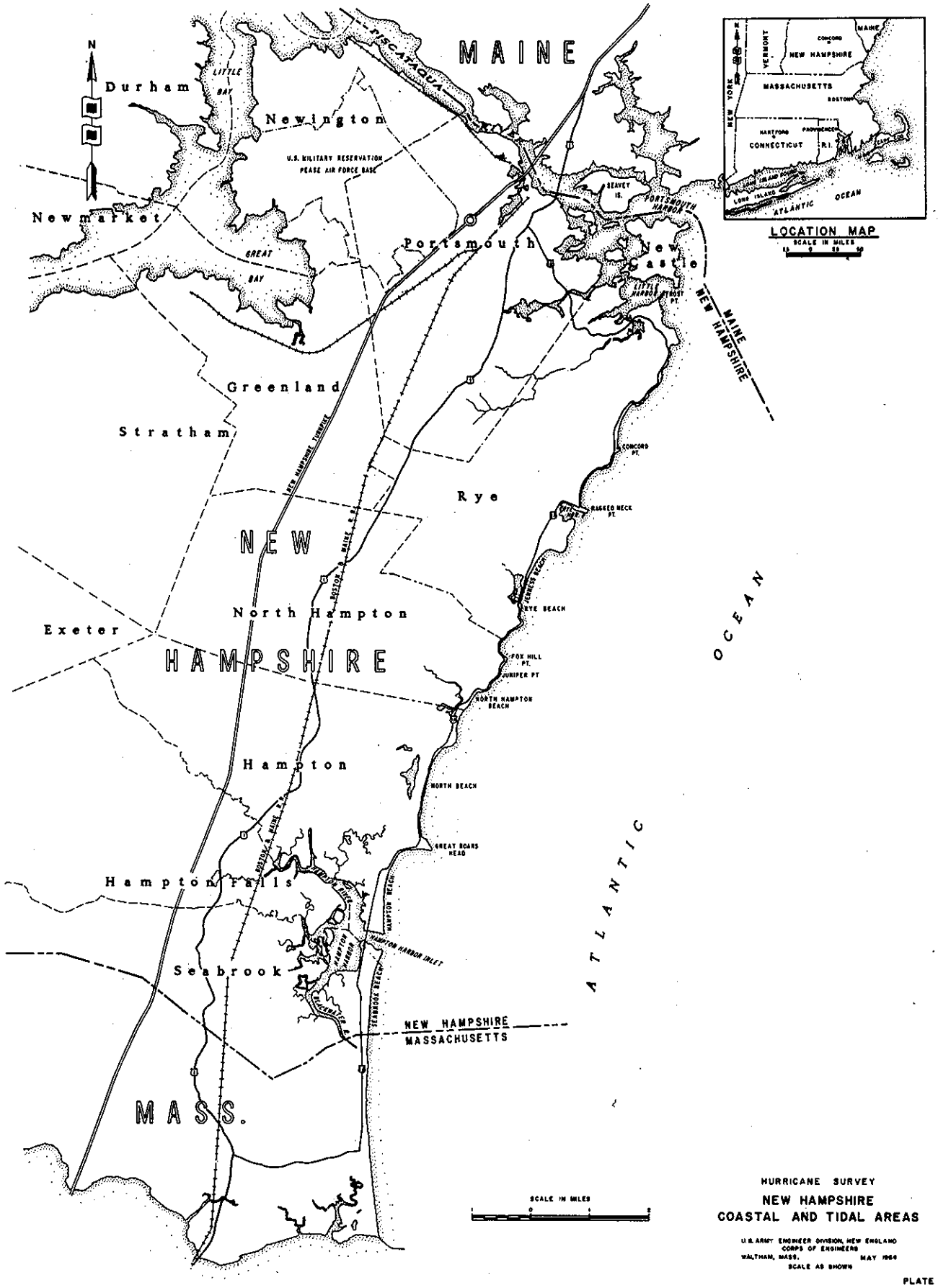
13. It is recommended that no improvements for hurricane protection in the coastal and tidal areas of New Hampshire be undertaken by the United States at this time.

It is further recommended that this report be printed to serve as a guide to public and private interests in their long-range planning for the full development of the lands, waters and other natural resources of the New Hampshire coastal area.

It is also recommended that this report be accepted as complying in full with the directive contained in Public Law 71 insofar as it pertains to New Hampshire.

P. C. HYZER
Brigadier General, USA
Division Engineer

Incl.
Map



HURRICANE SURVEY

NEW HAMPSHIRE COASTAL AND TIDAL AREAS

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS. MAY 1964
SCALE AS SHOWN

PLATE I